UNIVERSITY OF AGRICULTURAL SCIENCES AND VETERINARY MEDICINE
„ION IONESCU DE LA BRAD"
FACULTY OF AGRICULTURE
DOCTORAL DOMAIN: AGRONOMY
SPECIALIZATION: PRODUCTION AND PRESERVATION OF FORAGE CROPS

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DOCTORAL THESIS SUMMARY

ECOLOGICAL, BIOLOGICAL AND AGRO PRODUCTIVE STUDY OF GRASSLANDS IN THE UPPER BASIN OF SUCEAVA

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IASI -2013

SUMMARY

Keywords: vascular species, plant associations, organic fertilizer, biodiversity, productivity, quality

In conducting the research on the flora and vegetation of natural pastures in the upper basin of the Suceava River, we assumed that, to effectively exploit natural grasslands without disturbing the structural and functional balance in the millennial established grassland ecosystems, it is mandatory to have a vast, multi-criteria knowledge of the species that form the structure of these grassland, how they associate in establishing plant communities and how they react in different management situations.

In this respect, the present paper aims to study, from a ecological, biological and agro-productive point of view, the grasslands of the upper basin of the Suceava River.

The study objectives are: preparation of a summary of the vascular species in the study area; description of the main plant associations identified in the study area, analysis of the influence of organic fertilization on the bio-productivity and phytodiversity of *Agrostis capillaris* L. - *Festuca rubra* L. grasslands in the upper basin of the Suceava River, analysis of the influence of organic fertilization on the quality of the obtained forage, identifying the optimum amount of manure that can be used to fertilize the *Agrostis capillaris* L. - *Festuca rubra* L. grasslands in the upper basin of the Suceava River.

The thesis is divided into two parts and encompasses six chapters.

The first part, which contains 56 pages (30% of the thesis), representing Chapters I, II and III, is a study of the specialized literature, aiming to understand the current state of research that relate to the productivity, quality and biodiversity of permanent grasslands.

Chapter I presents the definition, classification, importance, distribution and economic and ecological importance of meadows and a characterization of pastures in the nemoral floor - the beech forests sublevel and mixed coniferous and boreal beech floor (the spruce forests) in Romania.

Chapter II covers the research conducted, in the country and abroad, on the influence of applied management on biodiversity, productivity and quality of feed from permanent grasslands.

The description of the natural conditions of the area where the study was conducted is rendered in **Chapter III**. The area under study is located in northern Suceava county, near the Ukraine border, between 47˚46´31˝ and 47˚55´54˝ North latitude, 25˚10´59˝ and 25˚49´37˝ East

longitude. The area in question lies in the upper basin of the Suceava River, with an altitude ranging between 530 m and 1380 m, on the north eastern side of the Obcina Mare of the Eastern Carpathians.

The morphogenetic types that characterize the landscape are complex in structure suitable mountains geosyncline folded flysch, highlighted by small and medium-sized mountains with rounded parallel ridges separated by depressions elongated hillock relief (chine type).

From the administrative point of view, the territory belongs to the jurisdiction of the Izvoarele Suceavei, Ulma, Brodina, Putna, Straja communes.

In terms of Romanian Geography, the studied area is classified as moderate continental climate, the climate of the Eastern Carpathians, district forest and mountain meadows, Obcinile Bucovinei topoclimate, with an average annual temperature of 6.4 ºC and 12.8 ºC, during the growing season, rainfall annual average of 855 mm and 550 mm during the growing season.

The soils characteristic to this area are: brown, brown luvic, acid brown and local feriiluvial brown, in the nemoral floor - beech forests sublevel and mixed coniferous and beech feriiluvial brown, podzols, acid brown, brown rendzinas, regosols, lithosols in boreal floor.

Vegetation in the area under study corresponds, on the bottom floor, to the altitudinal nemoral - beech forest undergrowth and mixed beech and resinous, and, on top, to the altitudinal boreal floor.

In **Part II**, comprising 70% of the doctoral thesis (129 pages), consists of a Phytocoenology study of permanent grasslands and of manure fertilization influence on phytodiversity, productivity and quality of permanent *Agrostis capillaris* L. - *Festuca rubra* L. grassland in the upper basin of the Suceava River.

Chapter IV presents the purpose of the study, objectives, research methods and the description of the climatic conditions during the experiment.

To achieve the goal and objectives, observations were made in the 2008-2012 period, in most meadows in the upper basin of the Suceava River, during which botanical measurements were made, floral abstracts were prepared, with the aim of highlighting the existing plant associations. The phytocoenoses and plant associations study was conducted using the **phytocoenologic surveying method** and the qualitative indicators identified in grassland associations (pasturage nutritional value and grazing capacity) were determined based on media coverage of each species in the floristic structure and specific index of forage value.

To study how organic fertilization, widely practiced in the area, influences grasslands in terms bio-production, quality of the obtained forage and flora biodiversity, starting with the 2010 spring, a single factor study with five variants was held: V_1 - control (unfertilized), V_2 - 20 $Mg \cdot ha^{-1}$ annually, well fermented manure, V_3 - 20 $Mg \cdot ha^{-1}$ annually, well fermented manure, V_4 - 20 $Mg \cdot ha^{-1}$ annually, partially fermented stable manure, V_5 - 50 $Mg \cdot ha^{-1}$ annually, partially fermented stable manure in three repetitions, on a *Agrostis capillaris* L. + *Festuca rubra* L. meadow, in the Putna commune, Suceava county, situated at $47^0$49'41.25" North latitude,

25°36'29.73" East longitude and 611 metres altitude. The experimental variant area was 12 $m^{2.}$

The study activities also aimed to determine the dry matter content of CP (crude protein), DP (digestible protein), NDF (neutral detergent fiber), ADF (acid detergent fiber), ADL (acid detergent lignin), the calculation of relative forage (RFV), CF (crude fat) CA (crude ash), phosphorus, calculating NEL (net energy lactation), TDN (total digestible nutrients) and NFC (nonfibrous carbohydrates).

The analytical methodology has been applied in accordance with experimental techniques and standards. The data were interpreted statistically, by analysis of variance and limit differences calculation. Also, we calculated the regressions of correlations between the applied manure doses and the analyzed parameters.

In terms of temperatures, the 2009-2010 and 2010-2011 crop years were close to a normal year, the average per year being 0.6 ºC higher than the annual average. The growing season was warmer than normal, average temperature being 1.2-1.3 ºC higher than normal. The 2011-2012 agricultural year was warmer than a normal, average annual temperature being 3.1 °C higher than the annual average. The growing season was warmer than normal, average temperatures were 2.5 °C higher.

As for rainfall, the 2009-2010 agricultural year had an excess quantity of rainfall. The annual amount of rainfall is 965.3 mm, 332.7 mm higher than the annual average of 632.6 mm. The amount of rainfall recorded during the growing season was 730.0 mm, 261.8 mm higher than the annual average of 468.2 mm. The 2010-2011 agricultural year was a dry year. The annual amount of rainfall was 488.8 mm, 143.8 mm less than the annual average of 632.6 mm. The amount of rainfall recorded during the growing season was 352.5 mm, 115.7 mm less than the annual average of 468.2 mm. The 2011-2012 agricultural year showcased lower precipitations than a normal year. The annual amount of rainfall was 545.5 mm, 87.1 mm less than the annual average of 632.6 mm.

Chapter V presents the results of **the study of permanent grassland phytocoenology in the upper basin of Suceava River**.

Following the processing of field data, we have drafted a taxonomic compendium of the vascular flora of natural grasslands in the upper basin of the Suceava River, which includes a number of 343 species belonging to 190 genera, 44 families, 37 orders, 6 classes and 2 phyla in the *Plantae* world.

In the studied area (rather limited in size), we have found a remarkable floristic richness, representing approx. 14% of all vascular flora of Moldova, the majority of taxa belonging to the *Magnoliophyta* phylum (336 species), and only 7 species belonging to the *Polypodiophyta* phylum.

The main botanical families represented in grassland flora in the upper basin of Suceava are: *Asteraceae*, *Poaceae*, *Fabaceae*, *Cyperaceae*, *Scrophulariaceae*, *Apiaceae*, *Lamiaceae*, *Rosaceae*, *Juncaceae*, with net predominance hemicryptophytes (65.6%), which are followed by

therophytes and hemitherophytes (16.6%), geophytes (12.5%), camephytes (3.8%) and helohidatophytes (1.5%).

The main species in the investigated grassland flora are Eurasian (46.7%), European (25.1%) and Circumpolar (12.8%), to which there can be added, in much lower amounts Cosmopolitan (6.1%), and Black Sea species (3.2%) etc.

The *Festuco rubrae-Agrostietum capillaris* association is the most representative association of meadows in the upper basin of the Suceava River, occupying the largest area, starting with the lower mountain sublevel (beech forest floor) and up to the upper mountain sublevel (spruce floor). In the *Festuca rubra* L. and *Agrostis capillaris* L. grasslands, vegetation covering the soil ranges between 40 and 90% in the typical sub-association (subas. *typicum* Coldea 1991), while in the nardetosum strictae sub-association, there is a low coverage of 5-40%. Exclusive use of these grasslands for grazing leads to their degradation and the abundant development of the *Nardus stricta* L. species.

The following special pastoral associations are important in the investigated territory: *Agrostideto-Festucetum pratensis* (PNV = 4.2) *Arrhenatheretum elatioris* (PNV = 3.7) *Poo-Trisetetum flavescentis* (PNV = 3.7) *Festuco rubrae-Agrostietum capillaris* subas. *typicum* (PNV = 2.4). *Agrostideto-Festucetum pratensis* association is characterized as very good (Cc = 2.3 LU·ha^{-1}), and associations *Arrhenatheretum elatioris*, *Poo-Trisetetum flavescentis* and *Festuco rubrae-Agrostietum capillaris*. subas *typicum* are characterized as being good (Cc ranging from 1.4-1.8 LU·ha^{-1}). Other associations have been assigned the class of degraded grasslands (4 associations having a Cc between 0.2-0.4 LU·ha^{-1} and 8 associates with Cc below 0.2 LU·ha^{-1}).

Chapter VI presents the results of research on the influence of manure fertilization on biodiversity, productivity and quality of permanent *Agrostis capillaris* L. - *Festuca rubra* L. grasslands in the upper basin of Suceava.

Organic fertilization resulted in a series of changes in vegetation structure. The average coverage of the variants was different, depending on the quantity and quality of manure applied. The lowest average coverage occurred in the control, with 87.27%, augmenting by over 99%, with the increase of the amount of fertilizer applied to variants.

There are significant differences in terms of the species from different families participating in the vegetation cover. If the control (unfertilized) there is a greater participation of species of the family *Poaceae* and other families included in the miscellaneous category, the fertilized variants include a very significant increase in the percentage of species in the family *Fabaceae*, with high forage value, having positive effects on forage quality.

In 2010-2012, the application of manure in doses of 20-50 Mg·ha^{-1} resulted in very significant increases in total average production of between 135% and 251%, which highlights the importance of manure in productivity growth in the grasslands from the upper basin of Suceava River. The highest total average production was obtained by fertilization with 50 Mg·ha^{-1}annually, partially fermented stable manure (V_5), 3.80 Mg·ha^{-1} DM compared to 1.08 Mg·ha^{-1}

DM in the control variant. The average total production increased by 252% compared to the control V_1. The V_2 variant registered the lowest total average production growth, being fertilized with 20 Mg·ha^{-1} per year, well fermented manure, with a harvest of 2.55 Mg·ha^{-1} DM, and an increase of 136% compared to the control.

In all study years, total DM production positively correlated with the amount of manure applied, regression coefficient values being significant and very significant.

The quality of the obtained forage was influenced by manure, crude protein content increased significantly from year to year compared to the control. The highest growth was recorded in 2011, in the V_5 variant, with an increase of 46.4% (13.37 g·100g^{-1} DM), and the lowest, in the same year, in the V_2 variant - 6.1% (9.42 g·100g^{-1} DM) higher than the control.

The use of manure decreased, statistically, the feed content of the cell walls (hemicellulose, cellulose and lignin). By using manure, the NDF content decreased in all variants. The lowest NDF content was found in the V_4 variant in 2011, being 15.4% lower than the control, and the highest was registered in the V_2 variant, 5.1% lower than the control, in 2012.

Also, organic fertilization resulted in very significant decreases ADF feed content between 5.1% and 19.4% compared to the control. The ADL feed content was influenced differently in the three years of experiment. In 2010, there were increases of between 5.7% and 29.8%, in 2011 and 2012 ADL content decreased, the decrease ranging from 0 to 17.2% and from 2.2 to 7.1% compared to the control.

RFV is an important indicator of forage quality in assessing the nutritional value, being influenced by the degree of soil fertilization. In the study period, 2010-2012, there were only significant differences identified, the largest increase was found in the V_4 variant (2011), 32.7% relatively higher, while the lowest increase was found in the V_2 variant (2012), 11.4% lower than the control.

Fertilization with manure resulted in an average increase of the NFC content (nonfibrous carbohydrates) to 23.5% compared to the control, except for the V_5 variant, in 2011, registering a 18.4% decrease.

In 2010-2012 NEL significant increases in all fertilized variants, with values ranging between 10.0 Mcal·kg^{-1} DM and 23.7 Mcal·kg^{-1} DM, compared to the control.

Organic fertilization also influenced the TDN content of fodder (digestible protein + digestible fat + digestible cellulose + assimilated minerals + vitamins), which is significantly higher in all rehearsals and all variants, compared to controls in the three years of experiments. Increased TDN content ranged from 8.9% (V_2 in 2010 with 49.32 g·100g^{-1} DM) to 21.4% (V_2 in 2011 with 59.19 g·100g^{-1} DM).

The final part of the thesis presents the conclusions and recommendations drawn from this study, as well as a summary of the bibliography consulted during the completion of this work.